

Enhancements and Implications of IEC 61300-3-35 Edition 3 for Fiber Optic Connector Inspection

1.0 Introduction

The International Electrotechnical Commission (IEC) is a globally recognized standards organization responsible for developing and publishing international standards across a wide range of technologies, including fiber optics. IEC standards are crafted by subject matter experts through consensus, ensuring the safety, efficiency, reliability, and interoperability of various technologies. This white paper delves into the updates introduced in IEC 61300-3-35 Edition 3, published in September 2022, which addresses the visual inspection of fiber optic connectors and fiber-stub transceivers.

The paper will highlight modifications to the failure criteria, the addition of a new connector category, and the clarified role of visual inspection. The analysis, backed by empirical data, presents a comprehensive understanding of the implications of these changes for stakeholders in the field of fiber optic network deployment and maintenance.

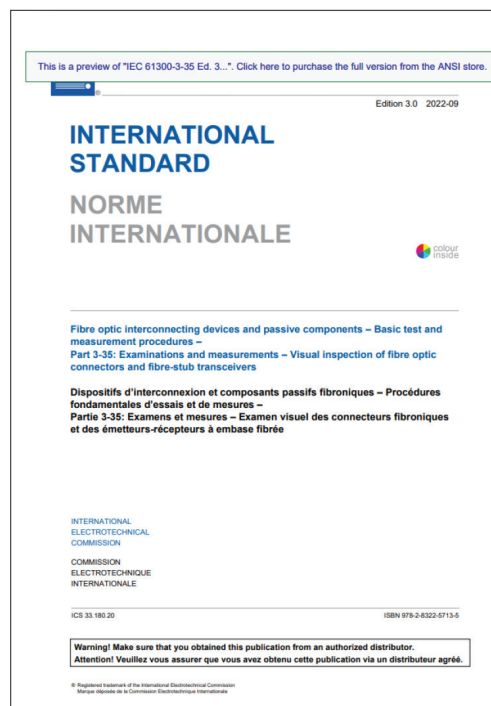


Figure 1: The 3rd edition of IEC61300-3-35 is now available and has several critical changes

2.0 IEC 61300-3-35 Standard Overview

IEC 61300-3-35 Edition 3 focuses on the visual inspection of fiber optic connectors and fiber-stub transceivers. It centers on the observation and classification of debris, scratches, and defects. The standard outlines the procedure and criteria for inspecting fiber-optic end faces to assess their cleanliness and suitability for integration into fiber optic networks.

For more information on the standard and its implementation, please refer the VIAVI white paper title ["Achieving IEC Standard Compliance for Fiber Optic Connector Quality through Automation of the Systematic Proactive End Face Inspection Process"](#) which is available at viavisolutions.com.

The IEC 61300-3-35 standard has undergone significant revisions in its third edition. This white paper delves into these changes, highlighting their impact on fiber optic connector inspection. The paper is intended to guide network architects, engineers, and managers in their selection of inspection criteria and decision-making processes when deploying fiber optic networks.

3.0 Changes Introduced in Edition 3

The sections below will highlight the key changes to the standard.

3.1 Failure Criteria Changes

Edition 3 introduces three key modifications to failure criteria:

a. Removal of inspection zones C and D:

- Edition 3 eliminates failure criteria outside the cladding zone, reducing the inspection area by 79%.

Edition 2 SM UPC		
Zone	Scratches	Defects
Zone A 0-25 µm	Fail if more than 0 scratches	Fail if more than 0 defects
Zone B 25-115 µm	Fail if any width is more than 3 µm	<ul style="list-style-type: none"> Fail if any diameter is more than 5 µm Fail if more than 5 defects Fail if diameter is less than 2 µm
Zone C 115-135 µm		
Zone D 135-250 µm		Fail if any diameter is more than 10 µm

Edition 3 SM UPC		
Zone	Scratches	Defects
Zone A 0-25 µm	Fail if any width is more than 3 µm	<ul style="list-style-type: none"> Fail if any diameter is more than 3 µm Fail if more than 1 defects Exclude if diameter is less than 2 µm
Zone B 25-110 µm		Fail if diameter is more than 25 µm

**No criteria outside cladding zone
Inspection area reduced by 79%**

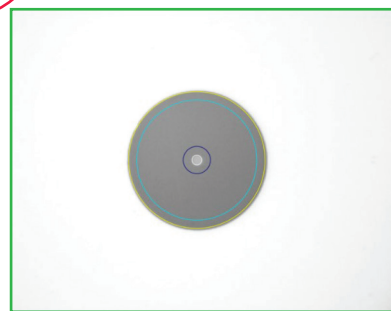
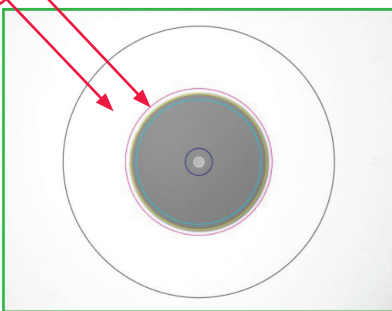


Figure 2: Comparison of the zones used in Edition 2 and Edition 3

3.1 Failure Criteria Changes continued

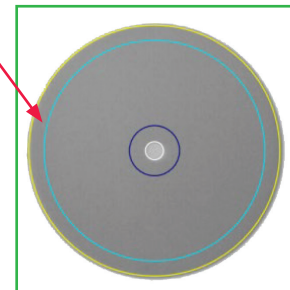
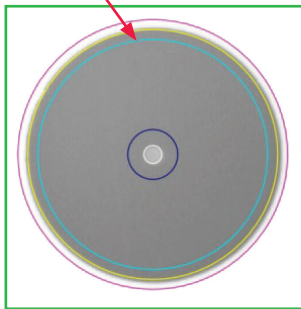
b. Zone B boundary diameter adjustment:

- Zone B boundary diameter is changed from 25 – 115 μm to 25 – 110 μm , leading to a 2% reduction in inspection area.

Edition 2 SM UPC		
Zone	Scratches	Defects
Zone A 0-25 μm	Fail if more than 0 scratches	Fail if more than 0 defects
Zone B 25-115 μm	Fail if any width is more than 3 μm	<ul style="list-style-type: none"> Fail if any diameter is more than 5 μm Fail if more than 5 defects Fail if diameter is less than 2 μm
Zone C 115-135 μm		
Zone D 135-250 μm		Fail if any diameter is more than 10 μm

Edition 3 SM UPC		
Zone	Scratches	Defects
Zone A 0-25 μm	Fail if any width is more than 3 μm	<ul style="list-style-type: none"> Fail if any diameter is more than 3 μm Fail if more than 1 defects Exclude if diameter is less than 2 μm
Zone B 25-110 μm		Fail if diameter is more than 25 μm

Cladding diameter reduced by 5 μm
Overall inspection area reduced by 2%



3.1 Failure Criteria Changes continued

c. Changes in allowable defect quantity and size:

- Scratches and defects in different zones are subjected to new specifications in Edition 3, allowing for more and larger scratches and defects.

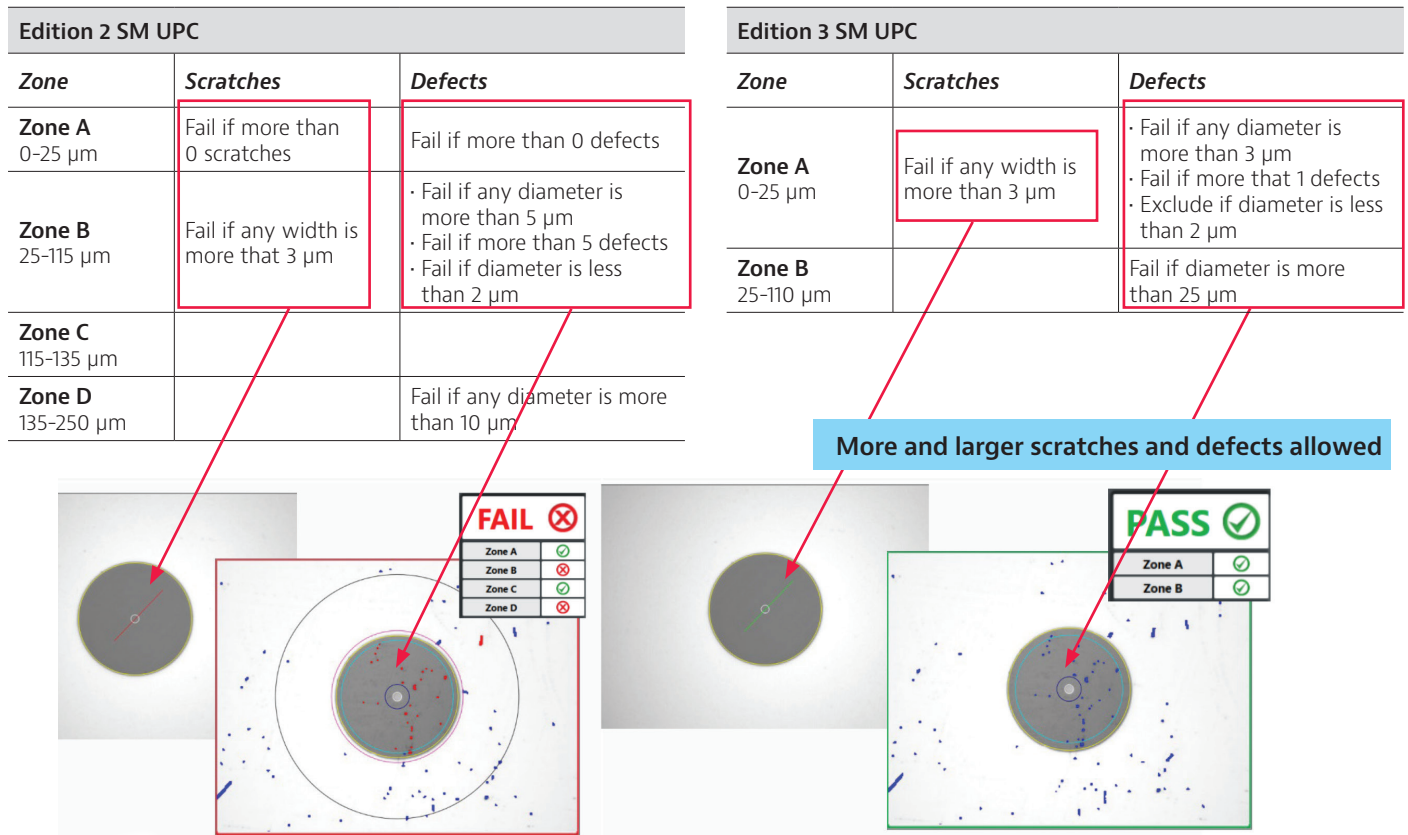


Figure 4: Simple example showing the impact of the defect quantity size and quantity changes

3.2 Addition of New Connector Category

A new connector category is introduced in Edition 3 – single-mode PC connectors with return loss (RL) \geq 35dB. This addition aligns with the aim to encompass a wider range of connector types, with slight differences in scratch criteria compared to the 26dB RL category.

Edition 2 SM PC RL \geq 35 dB	Edition 3 SM PC RL \geq 35 dB		
<i>Not specified in edition 2</i>	Zone	Scratches	Defects
	Zone A 0-25 μ m	<ul style="list-style-type: none"> · Fail if more than 0 scratches · Fail if any width is more than 4 μm · Exclude if width is less than 3 μm 	<ul style="list-style-type: none"> · Fail if any diameter is more than 3 μm · Fail if more than 1 defects · Exclude if width is less than 2 μm
	Zone B 25-115 μ m		<ul style="list-style-type: none"> · Fail if any diameter is more than 25 μm

New in edition 3

Edition 3 SM PC RL \geq 26 dB		
Zone	Scratches	Defects
Zone A 0-25 μ m	<ul style="list-style-type: none"> · Fail if more than 2 scratches · Fail if any width is more than 4 μm · Exclude if width is less than 3 μm 	<ul style="list-style-type: none"> more than 3 μm · Fail if more than 1 defects · Exclude if width is less than 2 μm
Zone B 25-115 μ m		<ul style="list-style-type: none"> · Fail if any diameter is more than 3 μm

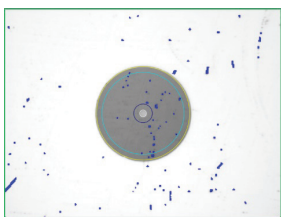
Minor difference between 35dB and 26dB RL categories

Figure 5: Edition 3 introduces a new connector category

3.3 Clarification of Visual Inspection Role

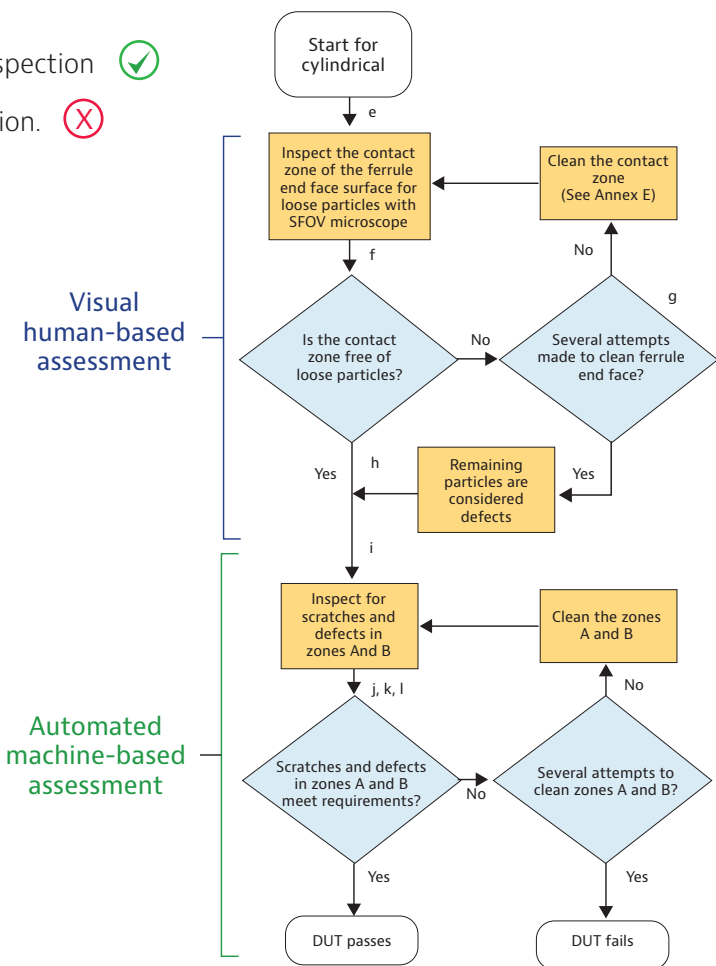
Edition 3 further elucidates the role of visual inspection, emphasizing its significance in preliminary assessment. Automated analysis is recommended only after several cleaning attempts, and automated analysis failure necessitates re-cleaning and re-analysis. The concept of Inspection Before You Connect (IBYC) remains a crucial prerequisite.

1. Visual, human-eye based inspection of end face for loose particles
2. If visually dirty → clean, then re-inspect visually
3. Automated analysis only after several cleaning attempts
4. If automated analysis fails → clean, then re-analyze
5. If automated analysis passes → connector passes inspection ✓
6. If analysis fails continually → connector fails inspection. ✗



Visual inspection before automated inspection

Continuous failure of automated analysis results in inspection failure. However, a connector that fails inspection might still be put into service after passing optical performance tests. It is crucial to note that failing the inspection step may lead to failure in optical performance tests.



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Figure 6: Edition 3 changes the work flow and adds the potential to evaluate the optical performance of a connector

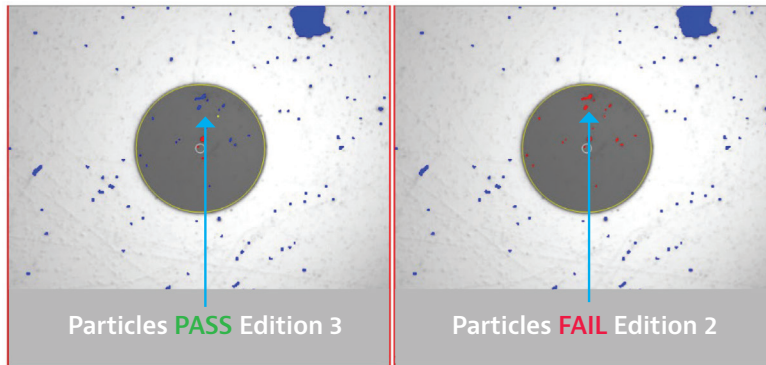
4.0 Comparative Analysis and Empirical Data

VIAMI collected images of mostly clean SC/UPC and SC/APC connectors and analyzed them using both Edition 2 and Edition 3 criteria. The focus on mostly clean fibers acknowledges the value of automated inspection in scenarios where the human eye's reliability is limited. The analysis aimed to highlight the differences in passing and failing results under the two editions.

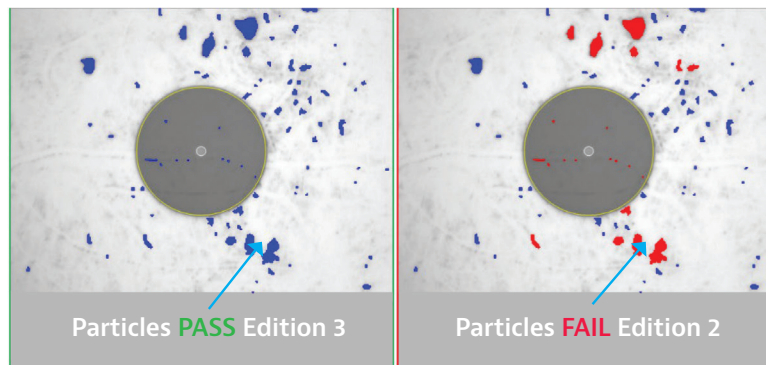
4.1 Examples and Results

Several examples were analyzed to illustrate the impact of the updated criteria:

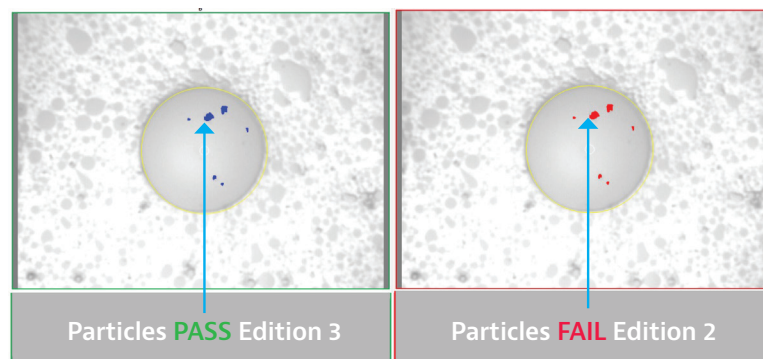
1. Example 1: A connector with numerous defects smaller than 25 microns in Zone B. While Edition 2 fails due to defects larger than 5 microns, Edition 3 passes since there is no limit on defects smaller than 25 microns.



2. Example 2: A connector with defects outside the fiber cladding. Edition 2 fails due to defects larger than 10 microns in Zone D, but Edition 3 passes as no criteria extend beyond Zone B.



3. Example 2a: A multi-fiber MT ferrule with multiple defects. Edition 2 fails due to a defect larger than 5 microns, while Edition 3 passes with no limit on defects smaller than 25 microns.



4.2 Comparative Analysis

VIAVI conducted a comprehensive comparative analysis using a diverse range of images containing various types of defects, encompassing both PC and APC connectors. This analysis, conducted on a considerably larger sample size, yielded insightful results regarding the differences between the Edition 2 and Edition 3 criteria.

Ferrule	Unique Images	Edition 3 Passes	Edition 2 Passes	Analysis Criteria
SC/UPC	28	17 (61%)	8 (29%)	SM UPC (IEC 61300-3-35 Ed. 2.0) SM PC RL45 (Ed. 3 IEC-61300-3-35)
SC/APC	34	24 (71%)	8 (24%)	SM APC (IEC 61300-3-35 Ed. 2.0) SM APC RL45 (Ed. 3 IEC-61300-3-35)

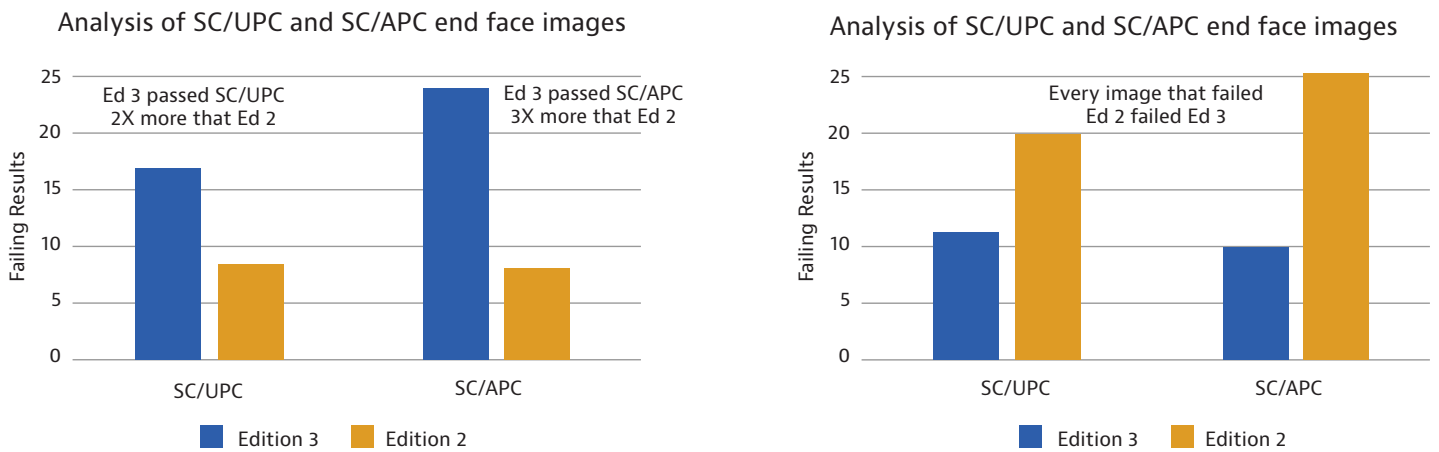


Figure 7: Results of a side by side study of connectors using Ed2 and Ed3

The findings of this analysis highlight that the Edition 3 criteria consistently produce a significantly higher number of passing results when compared to the Edition 2 criteria. The enlarged sample size enhances the reliability of these findings and underscores the impact of the revisions on connector inspection outcomes.

5.0 Conclusion and Recommendations

Based on a substantial sample size, the empirical analysis demonstrates that Edition 3's failure criteria are more lenient than those of Edition 2. This leniency results in a greater number of connectors passing the inspection under Edition 3. However, this also increases the potential of slightly contaminated fibers being put into service. Network architects, engineers, managers, and procurement groups have the flexibility to choose between the two editions when specifying acceptance criteria for fiber optic connector inspection. While connectors that pass Edition 2 will also pass Edition 3, the reverse may not hold true. A cautious approach would be to continue with Edition 2 if satisfied with existing network performance. On the other hand, Edition 3 criteria can offer more passing results but may involve an elevated risk of deploying slightly contaminated connectors. Stakeholders should weigh the benefits of potentially reduced testing and cleaning with Edition 3 against the increased confidence in network performance retained by adhering to Edition 2 criteria.

Accessing the IEC Standard

For those interested in obtaining the IEC 61300-3-35 standard, it is available for purchase through the ANSI Webstore. To access either Edition 2 or Edition 3 profiles for use with automated inspection microscopes, interested parties can contact VIAVI directly.



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